Claims

1. A variable optical attenuator device comprising a first optical waveguide, a second optical waveguide and at least one moveable reflective element having a variable orientation with respect to at least one of said first and second optical waveguides, wherein the device is arranged such that, in use, the optical beam output by the first optical waveguide is reflected from the at least one moveable reflective element and the orientation of the at least one moveable reflective element determines the efficiency with which the optical beam is coupled into the second optical waveguide, characterised in that the first and second optical waveguides are hollow core optical waveguides.

2. A device according to claim 1 wherein said at least one moveable reflective element has a controllable angular alignment with respect to at least one of said first and second optical waveguides.

3. A device according to claim 2 and arranged such that, in use, variation of the angular orientation of the moveable reflective element produces substantially no lateral displacement of the optical beam with respect to the second hollow core optical waveguide.

4. A device according to claim 1 wherein said at least one moveable reflective element has a controllable position with respect to at least one of said first and second optical waveguides.

5. A device according to any preceding claim wherein the first and second hollow core optical waveguides are formed in a common substrate.

6. A device according to claim 5 wherein the moveable reflective element comprises a micro-electro-mechanical system (MEMS) component formed in the common substrate.

7. A device according to claim 5 wherein the moveable reflective element comprises a hybrid MEMS component attached to the common substrate.

8. A device according to claim 7 wherein the moveable reflective component is held in alignment in an alignment slot formed in the common substrate.

9. A device according to any preceding claim wherein the moveable reflective element comprises a reflective coating.

10. A device according to any preceding claim wherein the moveable reflective element has a curved reflective surface

11. A device according to any preceding claim wherein the moveable reflective element comprises at least one deformable mirror.

12. A device according to any preceding claim and further comprising at least one additional reflective element having a fixed orientation, wherein, in use, the optical beam is reflected from both the at least one additional reflective element and the at least one moveable reflective element.

13. A device according to any preceding claim wherein further hollow core optical waveguides are provided to substantially guide the optical beam from the first optical waveguide to the second optical waveguide.

14. A device according to any preceding claim wherein the first optical waveguide is arranged to preferentially guide radiation propagating in a fundamental mode.

15. A device according to any preceding claim wherein the second optical waveguide is dimensioned to preferentially support the propagation of radiation in a fundamental mode.

16. A device according to any one of claims 1 to 14 wherein the second optical waveguide is dimensioned to support the propagation of multiple optical modes.

17. A device according to any preceding claim wherein the first optical waveguide and/or the second optical waveguide comprise a tapered section.

18. A device according to any preceding claim wherein the first optical waveguide and/or the second optical waveguide are of substantially rectangular cross section.

19. A device according to any preceding claim wherein the internal surfaces of the first optical waveguide and/or the second optical waveguide carry a reflective coating.

20. A device according to any preceding claim wherein a first optical fibre attachment means is provided to hold in alignment an input optical fibre, the input optical fibre being arranged to couple light into the first optical waveguide.

21. A device according to any preceding claim wherein a second optical fibre attachment means is provided to hold in alignment an output optical fibre, the output optical fibre being arranged to receive light from the second optical waveguide.

22. A device according to claim 21 wherein the second optical fibre attachment means is arranged to receive a single mode optical fibre.

23. A device according to any preceding claim and further comprising a beam dump.

24. A device according to any preceding claim that is formed in a substrate comprising semiconductor material.

25. A device according to claim 22 wherein the substrate comprises a silicon-on-insulator (SOI) wafer.

26. A device according to any preceding claim wherein the hollow cores of the first and second optical waveguides are formed by a base portion and a lid portion.

27. A device according to any preceding claim formed by micro-fabrication techniques.

28. A device according to claim 27 wherein the micro-fabrication technique includes deep reactive ion etching.

29. A device according to any preceding claim wherein the hollow core optical waveguide are arranged to guide light in a plane substantially parallel to the plane of the substrate.